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EXAMINER	
ROSENBERGER, FREDERICK F	

ART UNIT	PAPER NUMBER
2884	

DATE MAILED: 08/11/2006

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)	
	10/688,723	MAY, RANDY DEAN	
	Examiner	**Art Unit**	
	Frederick F. Rosenberger	2884	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *18 May 2006*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-21* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☒ Claim(s) *21* is/are allowed.

6)☒ Claim(s) *1-20* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *03 June 2005* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date *5/18/06*.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

DETAILED ACTION

Response to Amendment

1. Applicant's reply, filed 18 May 2006, has been received and entered. Accordingly, claims 8, 10, and 12 have been amended. No claims have been cancelled. Claim 21 has been added. Thus, claims 1-21 are currently pending in this application.

2. Applicant's amendment of the claims has successfully overcome the objection of claim 10 and the rejection of claim 8 under 35 U.S.C. 112, as detailed in paragraphs 3 and 5, respectively, of the previous Office action.

Claim Rejections - 35 USC § 103

3. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

4. Claims 1, 3, 10, and 13 are rejected under 35 U.S.C. 103(a) as being unpatentable over Cvetkovic (German Patent Publication # DE-3413914-A1 and new translation filed 18 May 2006) in view of Silver (Journal paper entitled "Frequency-modulation spectroscopy for trace species detection: Theory and comparison among experimental methods").

With regards to claims 1 and 13, Cvetkovic discloses a system for detecting trace amounts of water vapor in natural gas (English translation, page 11, 3rd paragraph) comprising:

Optical means in the form of color center laser **1** (Figure 1) as a light source, which emits light at substantially a single wavelength corresponding to a single absorption line at which water molecules absorb light at a substantially greater level than natural gas molecules (English translation, page 11, 3rd paragraph; page 12, 3rd paragraph);

Detection means in the form of a detector **10** (Figure 1) configured to detect the intensity of light emitted from the light source; and

Determination means in the form of electronics **7** (Figure 1; English translation, page 14, 1st paragraph) coupled to the detector for determining the level of water vapor in the natural gas.

By virtue of the use of the color center laser, the light source in the disclosure of Cvetkovic would emit a wavelength having a width sufficiently narrow to perform single line spectroscopy.

Cvetkovic do not address the electronics determining the water vapor level using single line harmonic spectroscopy.

However, Silver teaches that wavelength-modulation or harmonic spectroscopy using tunable laser sources was a popular spectroscopy method for selective gas sensors (see page 708, top of 2nd column). Further, Silver teaches that frequency-modulation techniques, which are similar to wavelength-modulation techniques (see

page 708, middle of 1st column), reduce detection noise and also remove the baseline slope seen in direct absorption measurements thereby improving detection sensitivity (see page 707, 1st column). In addition, Silver teaches that harmonic spectroscopy necessitates a simpler setup than frequency-modulation (page 708, middle of 1st column) and that harmonic spectroscopy is a preferred method for detection of absorption lines in the near IR regime (see discussion page 715).

Thus, it would have been obvious for a person having ordinary skill in the art at the time the invention was made to determine the water vapor level using harmonic spectroscopy since it was known in the art that such techniques are often used with tunable laser source gas sensors to improve detection sensitivity, as taught by Silver. Further, it would have been obvious to use harmonic spectroscopy to determine the water vapor concentration to take advantage of the simple implementation and preferred nature over frequency-modulation in the near IR regime, as taught by Silver.

With regards to claim 3, Cvetkovic discloses a color center laser (English translation, page 11, 3rd paragraph; page 12, 3rd paragraph);

With regards to claim 10, Cvetkovic disclose a method for determining trace amounts of water in natural gas comprising the steps of:

> Generating light using color center laser **1** (Figure 1) as a light source, which emits light at substantially a single wavelength corresponding to a single absorption line at which water molecules absorb light at a substantially greater level than natural gas molecules (English translation, page 11, 3rd paragraph; page 12, 3rd paragraph);

Passing the generated light through a sample of natural gas (Figure 1);

Detecting the light passed through the natural gas using a detector **10** (Figure 1) configured to detect the intensity of light emitted from the light source;

Determining the level of water in the natural gas using of electronics **7** (Figure 1; English translation, page 14, 1st paragraph) coupled to the detector.

Cvetkovic do not address the electronics determining the water vapor level using single line harmonic spectroscopy.

However, Silver teaches that wavelength-modulation or harmonic spectroscopy using tunable laser sources was a popular spectroscopy method for selective gas sensors (see page 708, top of 2nd column). Further, Silver teaches that frequency-modulation techniques, which are similar to wavelength-modulation techniques (see page 708, middle of 1st column), reduce detection noise and also remove the baseline slope seen in direct absorption measurements thereby improving detection sensitivity (see page 707, 1st column). In addition, Silver teaches that harmonic spectroscopy necessitates a simpler setup than frequency-modulation (page 708, middle of 1st column) and that harmonic spectroscopy is a preferred method for detection of absorption lines in the near IR regime (see discussion page 715).

Thus, it would have been obvious for a person having ordinary skill in the art at the time the invention was made to determine the water vapor level using harmonic spectroscopy since it was known in the art that such techniques are often used with tunable laser source gas sensors to improve detection sensitivity, as taught by Silver. Further, it would have been obvious to use harmonic spectroscopy to determine the

water vapor concentration to take advantage of the simple implementation and preferred nature over frequency-modulation in the near IR regime, as taught by Silver.

5. Claims 1, 2, 5, 6, 10, 13, and 17-19 are rejected under 35 U.S.C. 103(a) as being unpatentable over Kessler et al. (Conference Paper entitled "Near-IR Diode Laser-based Sensor for ppb-level Water Vapor in Industrial Gases") in view of Silver (Journal paper entitled "Frequency-modulation spectroscopy for trace species detection: Theory and comparison among experimental methods").

With regards to claims 1 and 13, Kessler et al. disclose a system for detecting trace amounts of water vapor in natural gas (see abstract, line 11) comprising:

Optical means in the form a tunable diode laser light source (page 144, section 2.1), emitting light at substantially a single wavelength corresponding to a single absorption line at which water molecules absorb light at a substantially greater level than natural gas molecules;

Detection means in the form of an InGaAs photodiode detector (page 144, section 2.1), configured to detect the intensity of light emitted from the light source;

Determination means in the form of computer module and data acquisition electronics (page 144, section 2.2) coupled to said detector for determining the level of water vapor in the natural gas;

Kessler et al. does not specifically address the electronics determining the water vapor level using single line harmonic spectroscopy.

However, Silver teaches that wavelength-modulation or harmonic spectroscopy using tunable laser sources was a popular spectroscopy method for selective gas sensors (see page 708, top of 2nd column). Further, Silver teaches that frequency-modulation techniques, which are similar to wavelength-modulation techniques (see page 708, middle of 1st column), reduce detection noise and also remove the baseline slope seen in direct absorption measurements thereby improving detection sensitivity (see page 707, 1st column). In addition, Silver teaches that harmonic spectroscopy necessitates a simpler setup than frequency-modulation (page 708, middle of 1st column) and that harmonic spectroscopy is a preferred method for detection of absorption lines in the near IR regime (see discussion page 715).

Thus, it would have been obvious for a person having ordinary skill in the art at the time the invention was made to determine the water vapor level using harmonic spectroscopy since it was known in the art that such techniques are often used with tunable laser source gas sensors to improve detection sensitivity, as taught by Silver. Further, it would have been obvious to use harmonic spectroscopy to determine the water vapor concentration to take advantage of the simple implementation and preferred nature over frequency-modulation in the near IR regime, as taught by Silver.

With regards to claims 2 and 17, Kessler et al. disclose a tunable diode laser (page 144, section 2.1).

With regards to claim 5, Kessler et al. disclose an InGaAs photodiode (page 144, section 2.1).

With regards to claim 6, Kessler et al. disclose a means for calibration of the system relative to known concentrations of water vapor (pages 145-146, section 4).

With regards to claim 10, Kessler et al. disclose a method for determining trace amounts of water in natural gas, comprising the steps of:

Generating light at a single wavelength using a tunable diode laser (page 144, section 2.1), which emits light at substantially a single wavelength corresponding to a single absorption line at which water molecules absorb light at a substantially greater level than natural gas molecules;

Passing the generated light through a sample of natural gas (see abstract, line 11);

Detecting the light passed through the gas using an InGaAs photodiode (page 144, section 2.1);

And determining the level of water within the natural gas based on the level of detected light using a computer module and data acquisition unit (page 144, section 2.2).

Kessler et al. does not specifically address the step of determining the water vapor level using single line harmonic spectroscopy.

However, Silver teaches that wavelength-modulation or harmonic spectroscopy using tunable laser sources was a popular spectroscopy method for selective gas sensors (see page 708, top of 2nd column). Further, Silver teaches that frequency-modulation techniques, which are similar to wavelength-modulation techniques (see page 708, middle of 1st column), reduce detection noise and also remove the baseline

slope seen in direct absorption measurements thereby improving detection sensitivity (see page 707, 1st column). In addition, Silver teaches that harmonic spectroscopy necessitates a simpler setup than frequency-modulation (page 708, middle of 1st column) and that harmonic spectroscopy is a preferred method for detection of absorption lines in the near IR regime (see discussion page 715).

Thus, it would have been obvious for a person having ordinary skill in the art at the time the invention was made to determine the water vapor level using harmonic spectroscopy since it was known in the art that such techniques are often used with tunable laser source gas sensors to improve detection sensitivity, as taught by Silver. Further, it would have been obvious to use harmonic spectroscopy to determine the water vapor concentration to take advantage of the simple implementation and preferred nature over frequency-modulation in the near IR regime, as taught by Silver.

With regards to claims 18 and 19, Kessler et al. disclose a multipass Herriott cell (page 144, section 2.3) and a means for supplying a flow of natural gas to the Herriott cell and thus across the light source.

6. Claims 3 and 4 are rejected under 35 U.S.C. 103(a) as being unpatentable over Kessler et al. and Silver, as applied to claim 1 above, and further in view of Inman et al. (US Patent # 6,188,475).

The combination of Kessler et al. and Silver disclose all the limitations of parent claim 1, as addressed above. However, the combination does not address that the light

source is either a color center laser or a quantum cascade laser. Instead, Kessler et al. only discuss the use of tunable diode lasers.

Inman et al. teach an in-line cell for absorption spectroscopy that employs a diode laser source to emit light at a wavelength characteristic of the impurity within the sample gas. For the light source, Inman et al. employ a tunable diode laser (column 5, lines 51-58). Inman et al. further point out that other suitably sized tunable lasers, such as fiber lasers or quantum cascade lasers, are equivalent to the tunable diode laser for absorption spectroscopy (column 6, lines 40-45).

Therefore, because these tunable lasers were art-recognized equivalents at the time the invention was made, one of ordinary skill in the art would have found it obvious to substitute a color center laser or a quantum cascade laser for a tunable diode laser.

7. Claims 7-9, 11, and 14-16 are rejected under 35 U.S.C. 103(a) as being unpatentable over Kessler et al. and Silver, as applied to claims 1, 10, and 13 above, and further in view of Murray, Jr. et al. (US Patent # 5,107,118).

The combination of Kessler et al. and Silver disclose all the limitations of parent claims 1, 10, and 13, as described above. However, the combination is silent with regards to the claimed wavelength ranges for the light sources. Instead, Kessler et al. discuss spectroscopy in the vicinity of the 1.3525μm absorption peak. Kessler et al. do recognize that the host gas (ammonia as detailed in the body of the paper) could interfere with the measurement through absorption at the same wavelength as water vapor absorption (see top of page 144).

Murray, Jr. et al. teach that the desired wavelength range for the absorption based measurement of water vapor in a sample gas is 2710nm to 2747nm, to allow for adequate differentiation between absorption due to water and due to the sample hydrocarbon gas (column 6, lines 32-38).

Thus, it would have been obvious for a person having ordinary skill in the art to use a wavelength range of 2710nm to 2747nm for the emitted wavelength of the laser source so as to provide adequate discrimination between the host natural gas and the contaminant water, as taught by Murray, Jr. et al. It would have been further obvious to one of ordinary skill in the art at the time the invention was made to use any of the wavelength ranges specified in claims 7, 9, 14, and 16, since it has been held that where the general conditions of a claim are disclosed in the prior art, discovering the optimum or working ranges involves only routine skill in the art. In re Aller, 105 USPQ 233.

8. Claim 12 is rejected under 35 U.S.C. 103(a) as being unpatentable over Kessler et al. (Conference Paper entitled "Near-IR Diode Laser-based Sensor for ppb-level Water Vapor in Industrial Gases") in view of Silver (Journal paper entitled "Frequency-modulation spectroscopy for trace species detection: Theory and comparison among experimental methods") and Brand et al. (US Patent # 6,064,488).

Kessler et al. disclose a system for detecting trace amounts of water vapor in natural gas (see abstract, line 11) comprising:

A light source, in the form of a tunable diode laser (page 144, section 2.1), emitting light at substantially a single wavelength corresponding to a single absorption line at which water molecules absorb light at a substantially greater level than natural gas molecules;

A detector, in the form of an InGaAs photodiode (page 144, section 2.1), configured to detect the intensity of light emitted from the light source;

Electronics, in the form of computer module and data acquisition unit (page 144, section 2.2) coupled to said detector for determining the level of water vapor in the natural gas;

A means for calibration of the system relative to known concentrations of water vapor (pages 145-146, section 4);

A multipass Herriott cell (page 144, section 2.3);

And a supply line for supplying a flow of natural gas to the Herriott cell and thus across the light source.

Kessler et al. does not specifically address the electronics determining the water vapor level using single line harmonic spectroscopy.

However, Silver teaches that wavelength-modulation or harmonic spectroscopy using tunable laser sources was a popular spectroscopy method for selective gas sensors (see page 708, top of 2nd column). Further, Silver teaches that frequency-modulation techniques, which are similar to wavelength-modulation techniques (see page 708, middle of 1st column), reduce detection noise and also remove the baseline slope seen in direct absorption measurements thereby improving detection sensitivity

(see page 707, 1st column). In addition, Silver teaches that harmonic spectroscopy necessitates a simpler setup than frequency-modulation (page 708, middle of 1st column) and that harmonic spectroscopy is a preferred method for detection of absorption lines in the near IR regime (see discussion page 715).

Thus, it would have been obvious for a person having ordinary skill in the art at the time the invention was made to determine the water vapor level using harmonic spectroscopy since it was known in the art that such techniques are often used with tunable laser source gas sensors to improve detection sensitivity, as taught by Silver. Further, it would have been obvious to use harmonic spectroscopy to determine the water vapor concentration to take advantage of the simple implementation and preferred nature over frequency-modulation in the near IR regime, as taught by Silver.

Kessler et al. also do not specifically address a sampling shelter for the optical gas sensor.

Brand et al. teach that the apparatus for sensing gas concentrations via gas absorption spectroscopy is housed within enclosure **40** (Figure 2 and column 3, lines 56-60), thus acting as a sampling shelter for attaching the sensor system to the wall **39** (Figure 2) of a stack or pipeline.

Thus it would have been obvious to a person having ordinary skill in the art to provide the sensor system of Kessler et al. and Silver in a sampling shelter to protect the sensor and allow it to connect to the pipeline of interest for sampling the gas under test, as taught by Brand et al.

9. Claim 20 is rejected under 35 U.S.C. 103(a) as being unpatentable over Kessler et al. and Silver, as applied to claim 1 above, and further in view of Paige (Conference Paper entitled "Commercial Gas Sensing with Vertical Cavity Lasers").

The combination of Kessler et al. and Silver disclose all the limitations of parent claim 1, as discussed above. However, Kessler et al. are silent with regards to the light source being a VCSEL. Instead, Kessler et al. employ a tunable diode laser for the light source.

Paige teaches that VCSELs are superior for gas sensing applications because of their wider tuning range, less divergence and rounder beam profile, as well as decreased susceptibility to optical feedback (page 141, first paragraph).

Thus, it would have been obvious for a person having ordinary skill in the art at the time the invention was made to include a VCSEL for the light source to take advantage of the VCSEL's wider tuning range, lower divergence, rounder beam profile, and decreased susceptibility to optical feedback, as taught by Paige.

With regards to the output range of the VCSEL, Paige teaches that VCSELs are available in wavelength ranges from 750nm to 960nm (page 141, 2nd paragraph). Paige further teaches that water vapor has an absorption line at 945nm (page 141, 3rd paragraph). Thus, it would have been obvious for a person having ordinary skill in the art at the time the invention was made to choose a range around the known absorption line for water vapor of 920nm to 960nm, since it has been held that where the general conditions of a claim are disclosed in the prior art, discovering the optimum or working ranges involves only routine skill in the art. In re Aller, 105 USPQ 233.

Allowable Subject Matter

10. Claim 21 is allowed.

11. The following is a statement of reasons for the indication of allowable subject matter:

Claim 21 recites a system comprising, among other elements, at least one chemical sensor for detecting a level of water vapor in natural gas, at least one optical sensor for detecting a level of water vapor in natural gas, and a supply line delivering natural gas to the at least one chemical sensor and the at least one optical sensor for parallel measurements.

The prior art fails to teach or reasonably suggest the combination of a chemical sensor and an optical sensor for detecting and making parallel measurements of the level of water vapor in natural gas. The cited prior art primarily teaches the use of optical spectroscopy to determine water vapor concentration in natural gas. Applicant's own disclosure further teaches that the use of chemical sensors in detecting water vapor in natural gas is common in the art. However, there is no motivation or suggestion within the prior art for combining both types of sensors in the parallel measurement of the level of water vapor in natural gas. As such, applicant's disclosure represents a novel and nonobvious improvement over the prior art. Thus, claim 21 is allowable.

Response to Arguments

12. Applicant's arguments, see page 9, 1st paragraph, filed 18 May 2006, with respect to the rejection(s) of claim(s) 1-20 under 103(a) have been fully considered and are persuasive. Therefore, the rejection has been withdrawn. However, upon further consideration, a new ground(s) of rejection is made in view of Silver.

It is agreed that May would not qualify as a reference under 35 U.S.C. 102 because of applicant's priority claim to the cited provisional application. However, the May reference was relied upon to teach what was common knowledge in the art. As such, Silver has been cited in the rejections above as evidence of similar teachings as those relied upon in the May reference. Further evidence of the teachings relied upon in the Silver reference and the May reference can be found in the attached Reid et al. reference (especially page 203, abstract and column 1).

Conclusion

13. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure. Reid et al. (Journal paper entitled "Second Harmonic Detection with Tunable Diode Lasers – Comparison of Experiment and Theory") teaches the use of harmonic spectroscopy in the detection of weak signals using tunable diode lasers, which results in significant improvement in signal to noise ratio (page 203, column 1).

14. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Frederick F. Rosenberger whose telephone number is

571-272-6107. The examiner can normally be reached on Monday-Friday 8:00 AM - 5:00 PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, David Porta can be reached on 571-272-2444. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

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